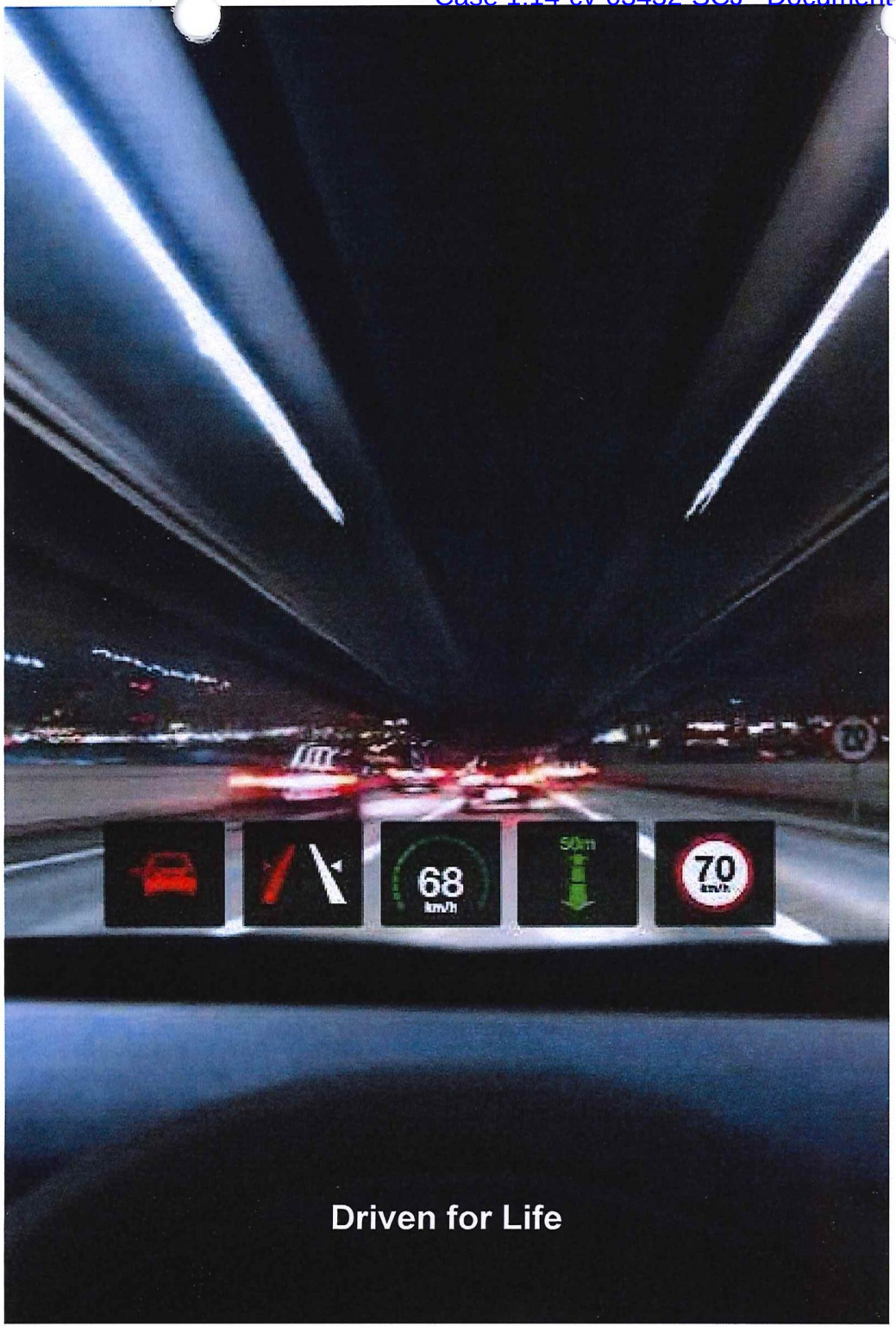

Basics of Seat Belts - Training

David Prentkowski
Autoliv - ATC
Sr. Principal Engineer – Seat Belt Engineering
Oct 2018

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Basics of Seat Belts

Agenda

- Primarily from a seat belts perspective (approx. 2 hrs. 15 minutes)
- What is an occupant restraint system?
- "Understanding Car Crashes" - IIHS Video
- "Understanding Car Crashes, When Physics Meets Biology" – IIHS Video
- Seat belt components in a system – overview
- What happens when?
- Basic Regulatory requirements for FMVSS 208/209 and ECE R16
- NCAP - New Car Assessment Program
- Product training (contact Core SB Product Eng. Mgrs. For training on separate modules for retractors, buckles, height adjusters, etc.) is NOT a part of this training.

Basics of Seat Belts

What is an "occupant restraint system"?

Seat belts and air bags, right?

Seat belts and air bags are major components of a vehicle manufacturer's overall occupant protection strategy.

Vehicle manufacturers define the overall occupant protection philosophy and strategy for their vehicles as well as the hardware needed to implement that protection strategy.

An "occupant restraint system" includes the vehicle body structure and deformation/energy absorption characteristics, seats, steering wheel, steering column, seat belts, seat belt anchorages, airbags, crash sensors and restraint system control module/program, as well as others.

Basics of Seat Belts

- "Understanding Car Crashes"
- Insurance Institute for Highway Safety Video

Show IIHS Video (approx. 22 minutes)

The physics of car crashes.
Basic equations of motion and their application….
Momentum
Energy
Work
Impulse

Older video and vehicles, but all principles still apply to current vehicles and restraint systems.

Basics of Seat Belts

- "Understanding Car Crashes, When Physics Meets Biology"
- Insurance Institute for Highway Safety Video

Show IIHS Video (approx. 24 minutes)

The physics of car crashes and the effects on occupants in the vehicle during a crash.

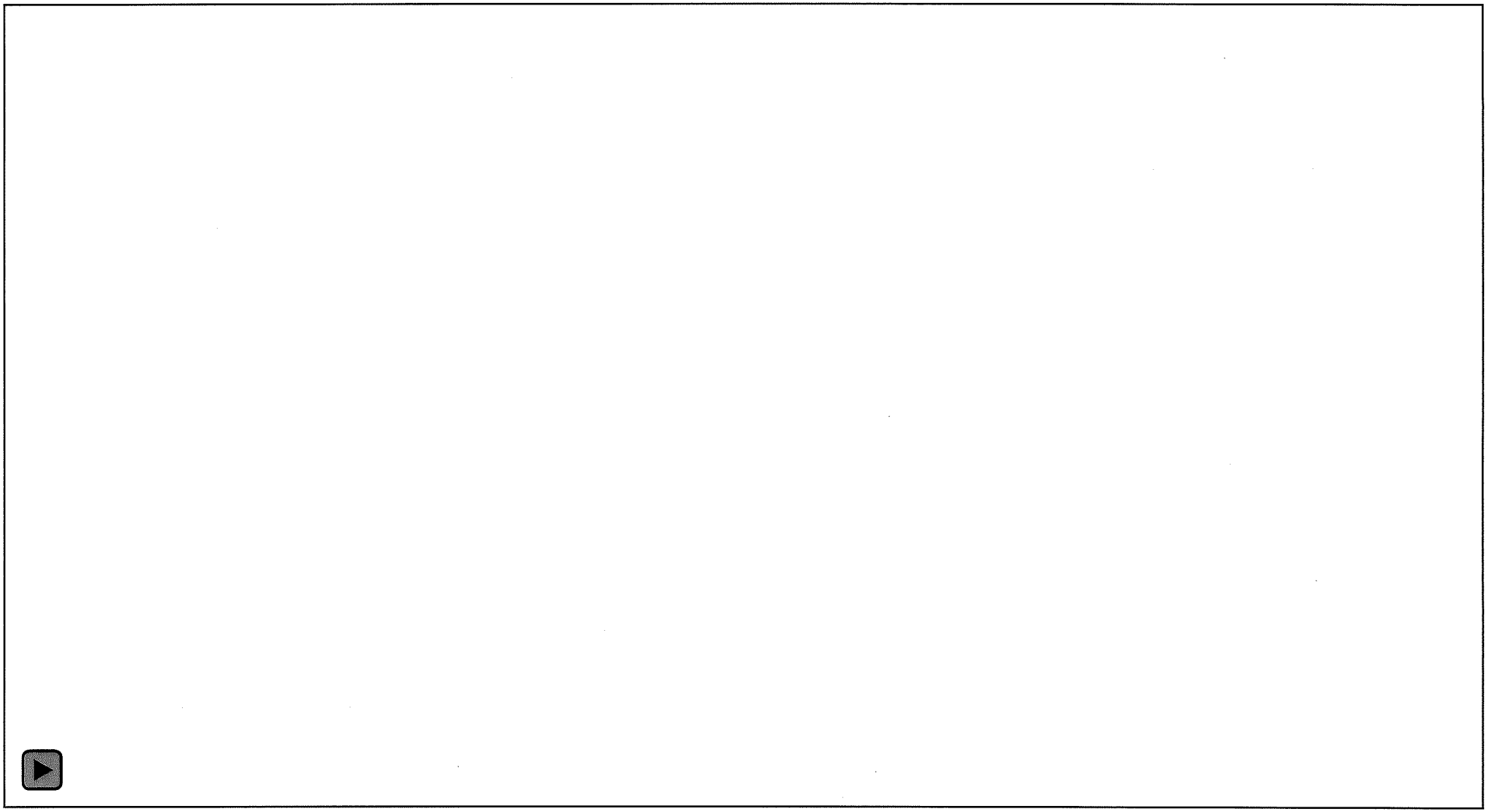
Relating actual crash tests to sled/simulation tests.

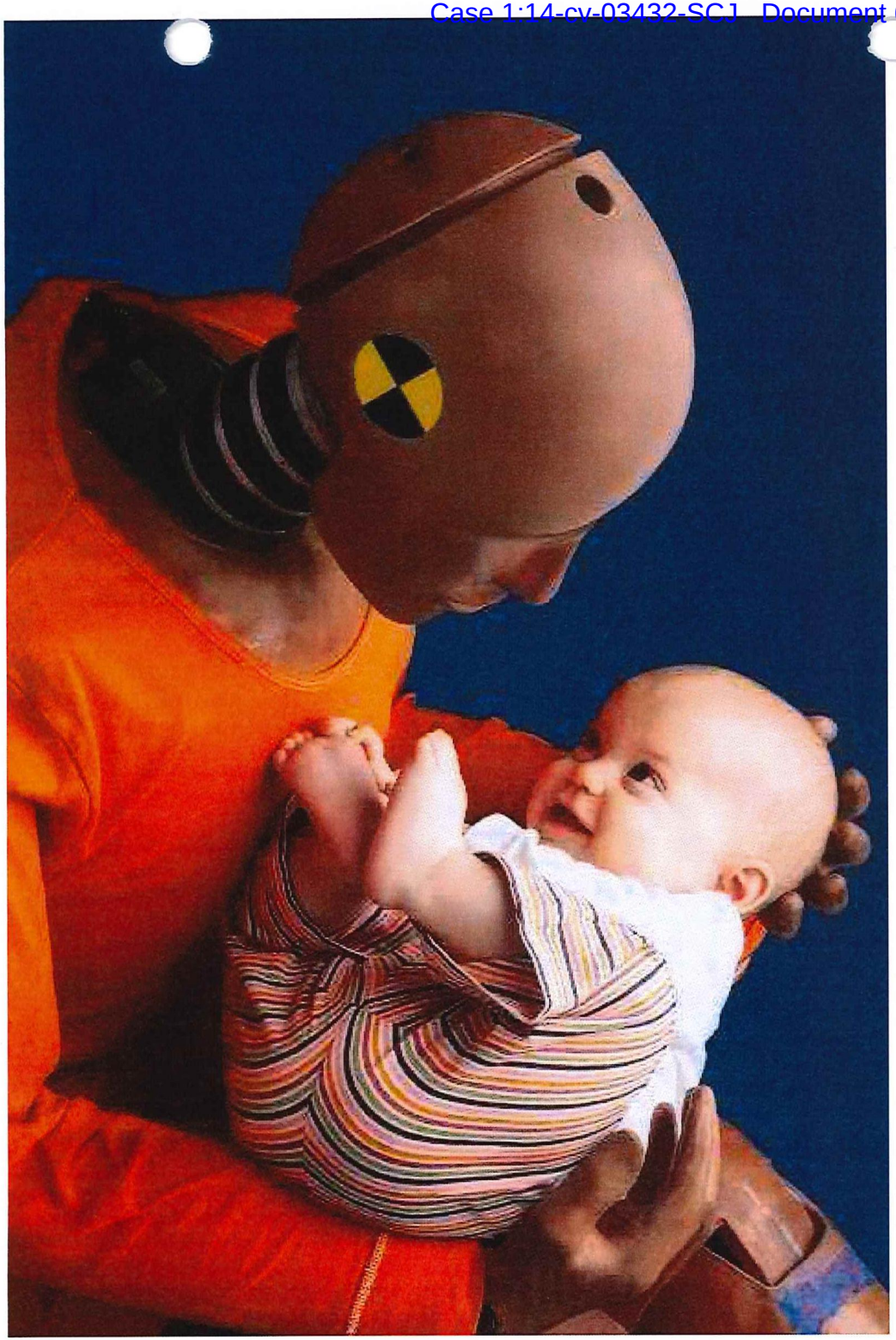
Basic anatomy of human body. Test dummies.

How body is affected by crash forces. 3 collisions.

How restraint systems mitigate injury.

Approx. 10 years newer than first video, but still older vehicles. All principles still apply.





Seat Belt System Components Overview

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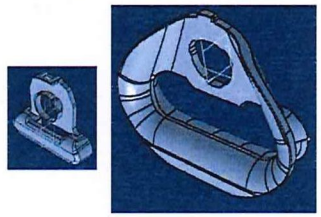
Typical Example - 3 Point Seat Belt

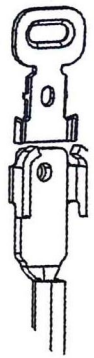
Pillar Loop / D-ring / Turning loop / Hanger / Guide loop

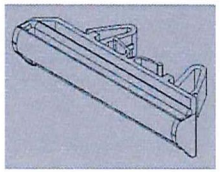


Different suppliers and Customers may use different names for these same components!

Free Falling Tongue/ Latchplate/Tip/ Connector

PLP Anchor Plate Connector





Midguide

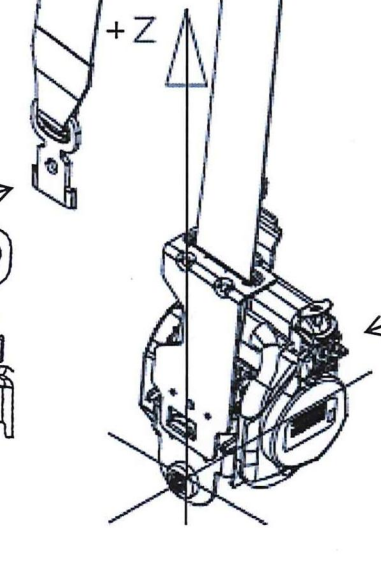
Snap-in version (non-handed) - sometimes included, sometimes not

Webbing

Standard webbing, typically about 3.2m in system

Retractor

ELR/ALR ret'r on passenger side. Upper stay bracket



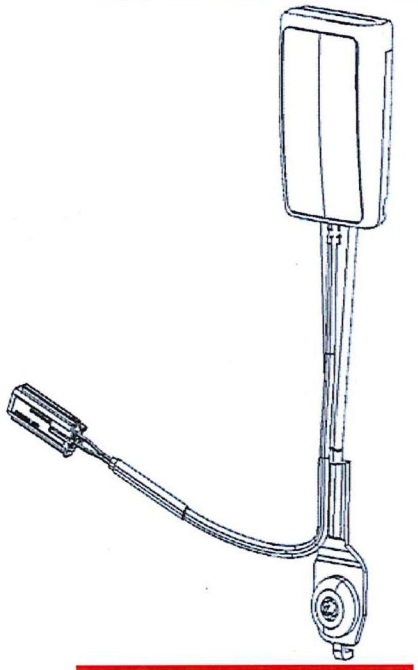
Sample pictures for reference only

Typical Example - Front Buckles, PLPs, & HAs

FMP20 Pillar loop

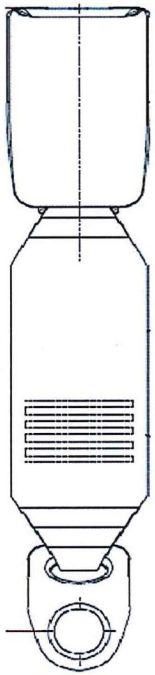
CLT - Crash LockingTongue

K12A Buckle

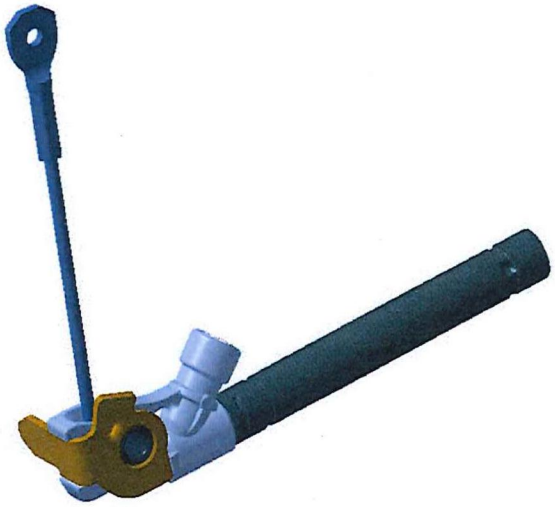


Buckle ass'y - on cable mount

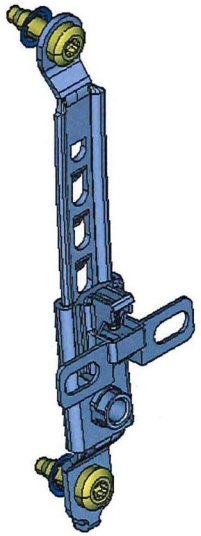
w/ Switch



Web mount Buckle



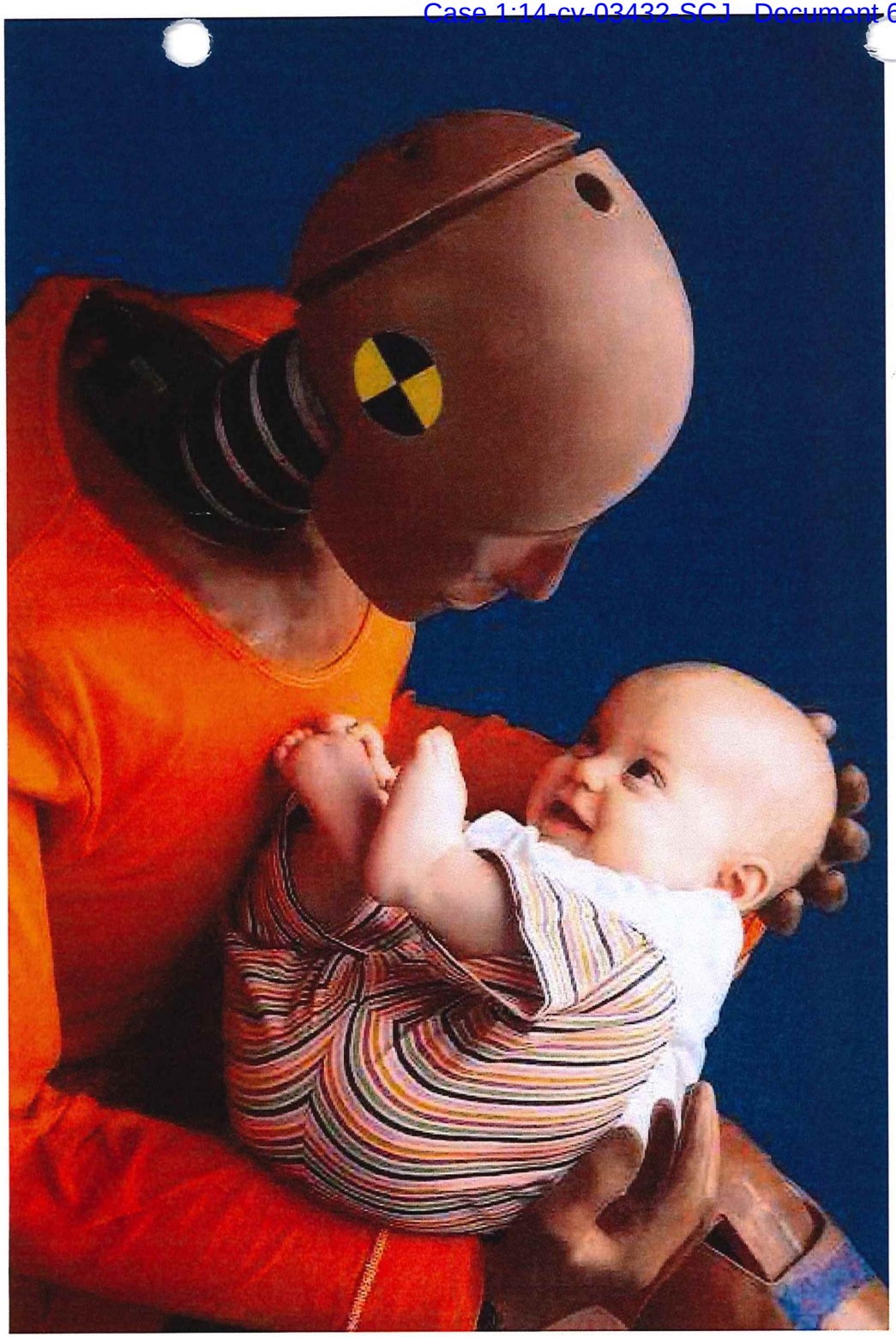
PLP - pyrotechnic lap pretensioner



Height Adjuster (HA60 shown)

2 Bolt design

Sample pictures for reference only



What Happens When?

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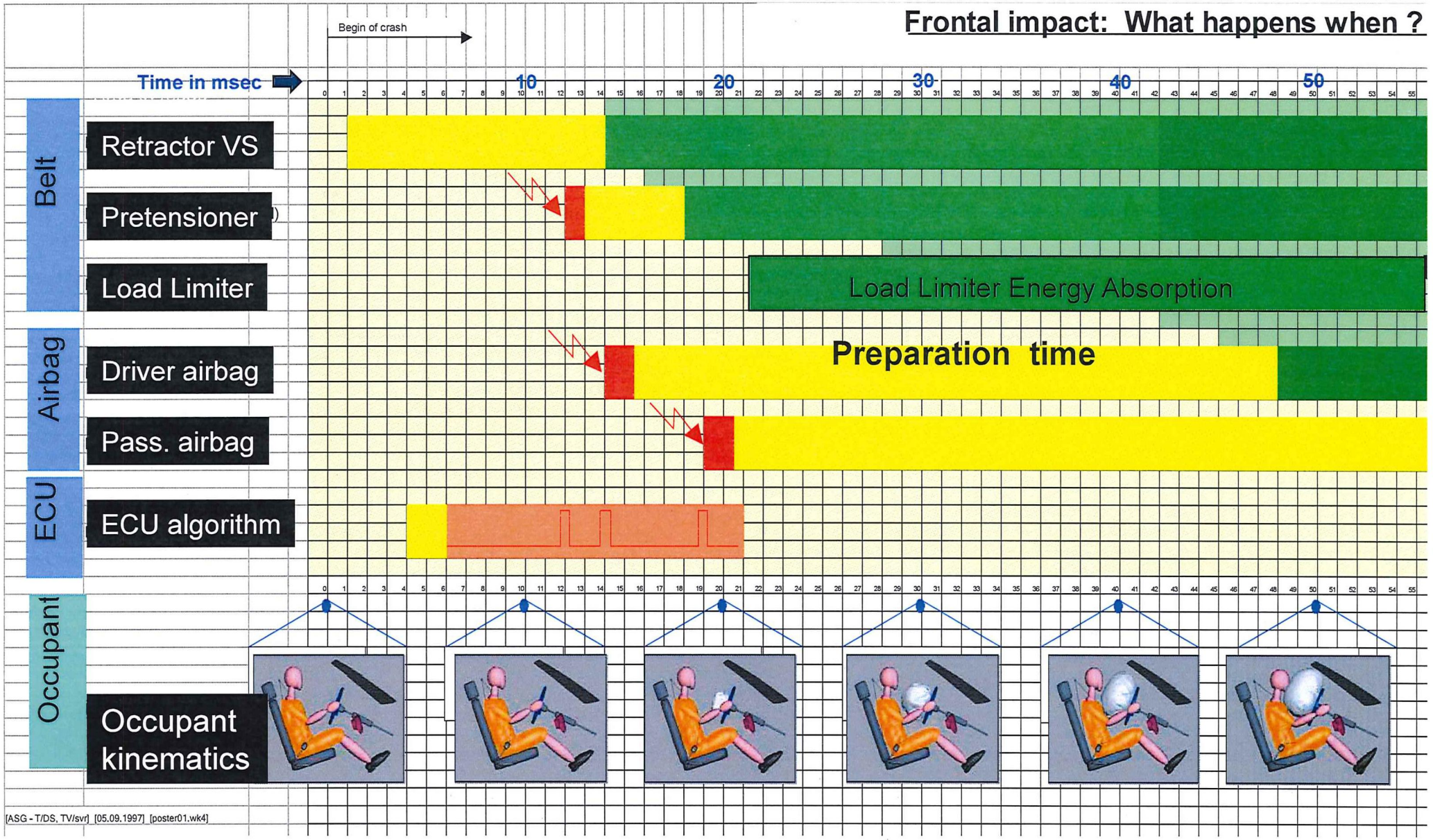
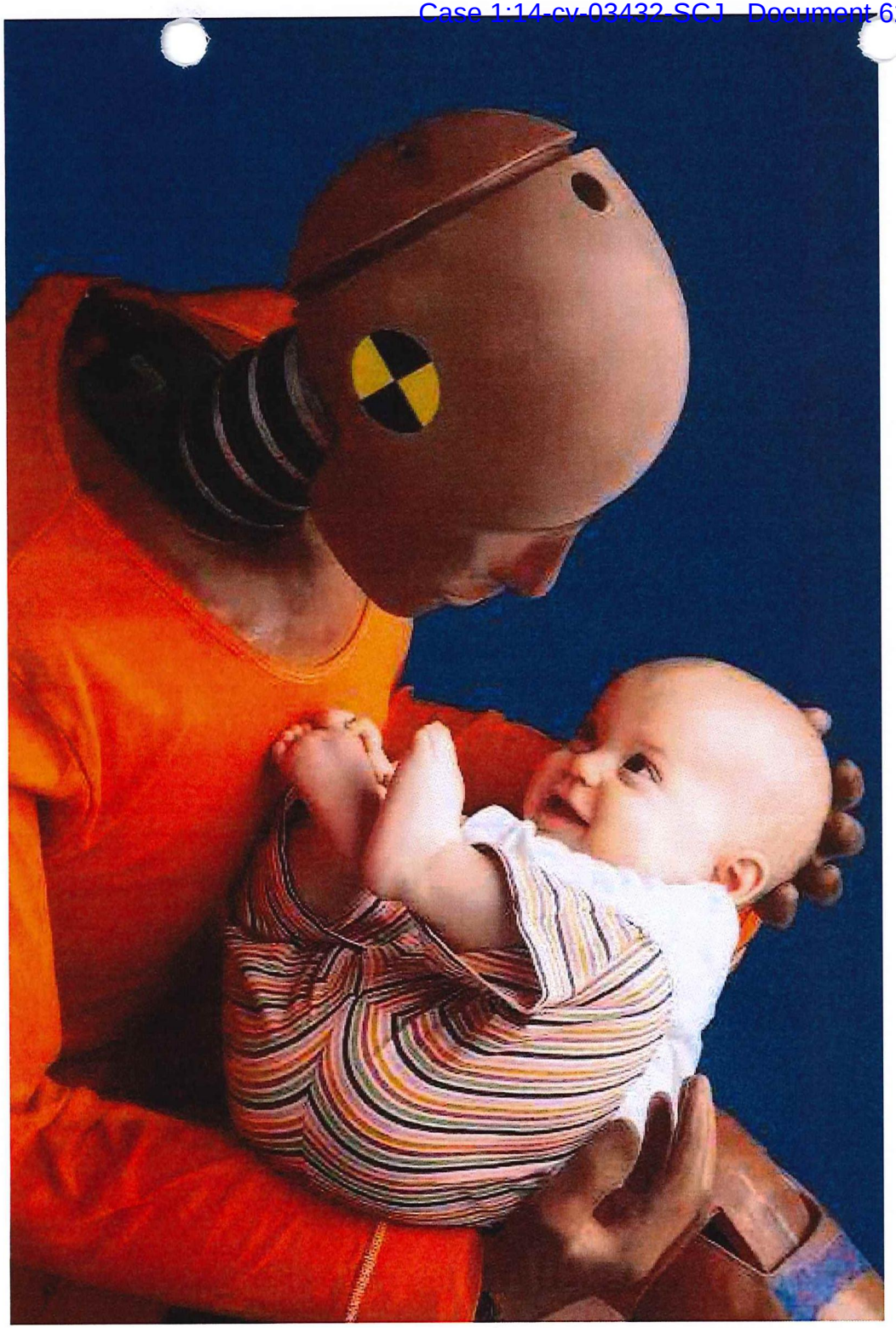
Frontal Impact: What happens when?



This example is generic.

The “blink of an eye” averages 200msec-300msec in length.



How Can Seat Belts Influence FMVSS 208 and NCAP Ratings?

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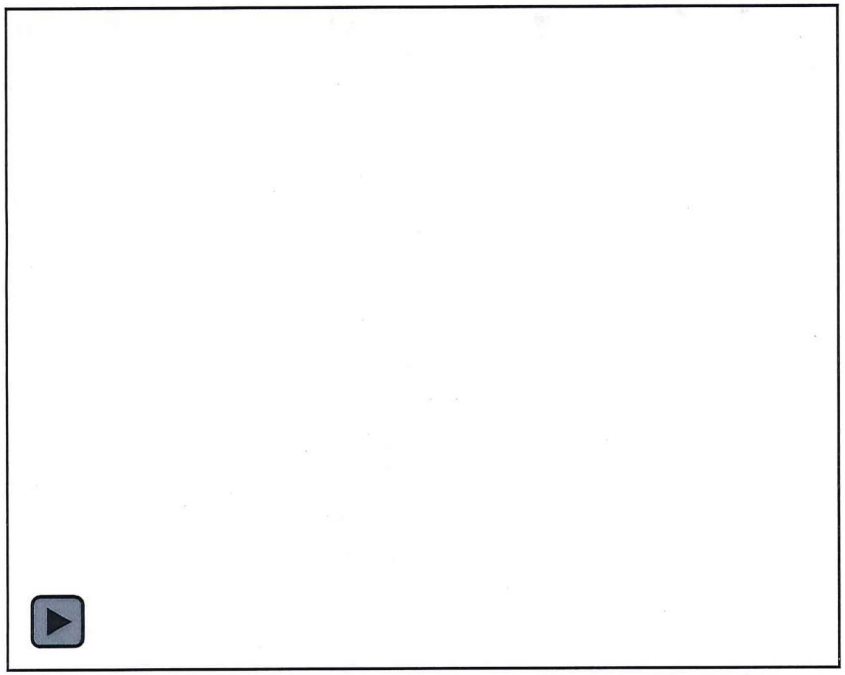
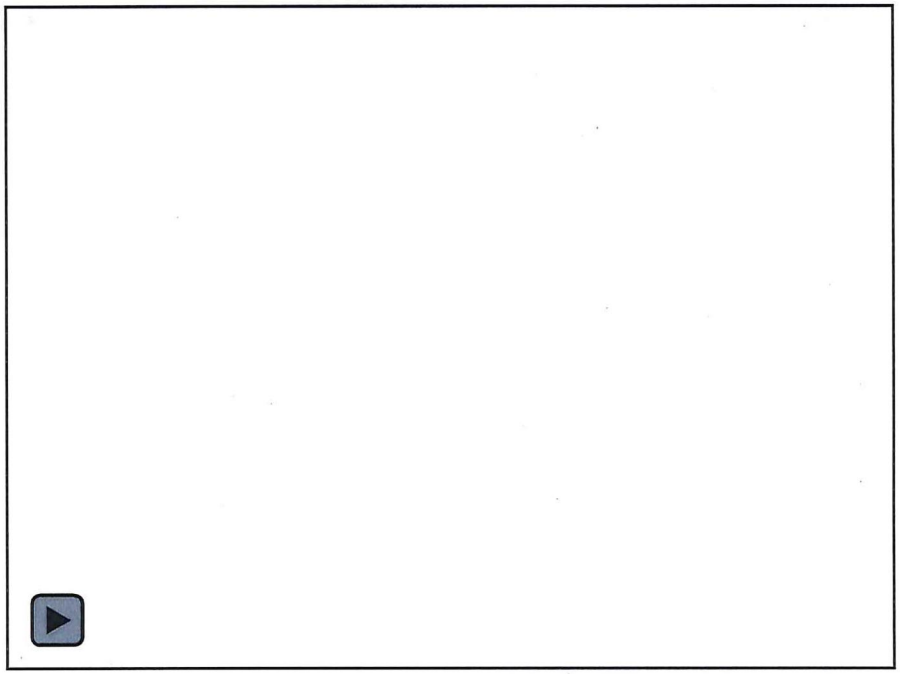
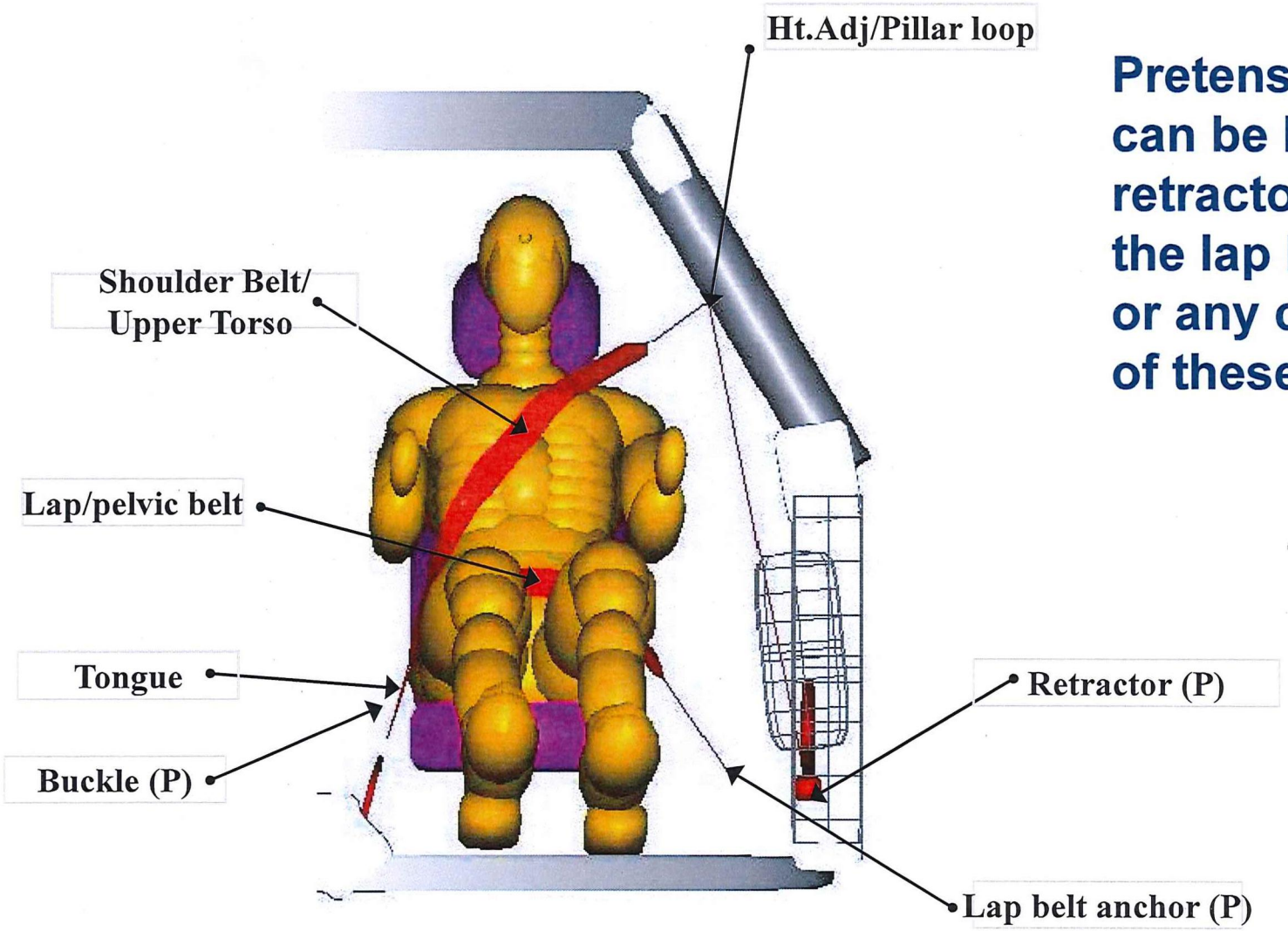
Seat Belt / Air Bag System Interface





- A higher NCAP rating is achieved by lowering peak “g’s” (HIC and chest “g”).
- Load limiters are used to reduce peak “g’s” on the occupant.
- Pretensioners are used to eliminate slack so occupant starts using energy management devices in the system as soon as possible in the crash event.
- Crash Lock Tongues (CLT) help to control upper torso loading and potentially reduce chest deflection.

Seat Belt – Terms and Pretensioner Locations



Driver's seating position – looking from front to rear

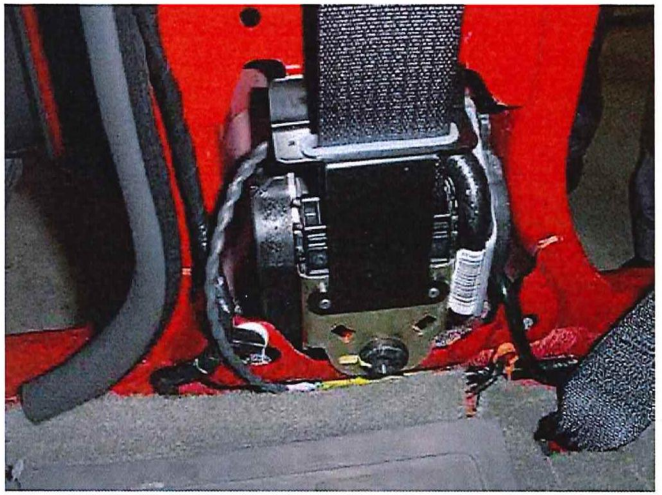
Pretensioners (P) can be located at the retractor, the buckle, the lap belt anchor or any combination of these

Pretensioner

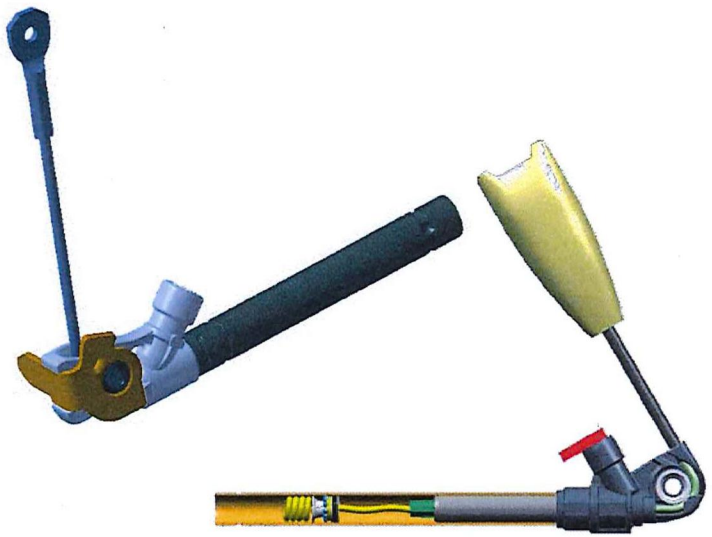
- Reduce the slack in real world (approximately 75mm - 110 mm)
- Closer and earlier coupling of the occupant to the car which provides earlier connection to energy management of the vehicle structure and restraint system devices.
- Provide better occupant position for interface with airbag (offset collision with vehicle rotation)
- Reduce probability of submarining (dependent on seat cushion structure, not all seats are the same)

What kind of pretensioners are available?

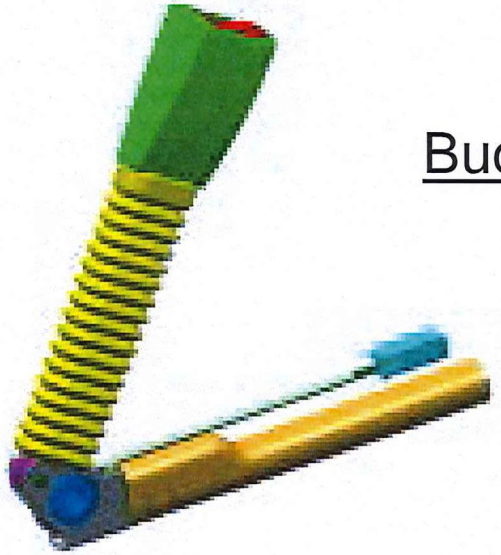
Retractor



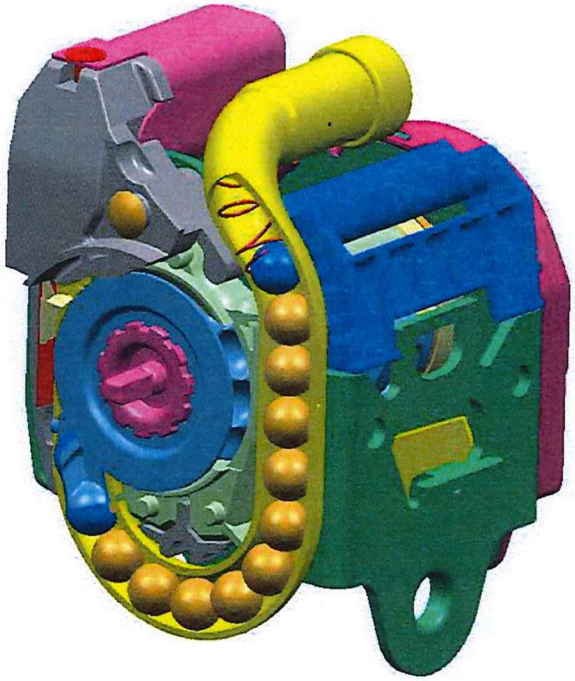
Lap/Anchor



Buckle

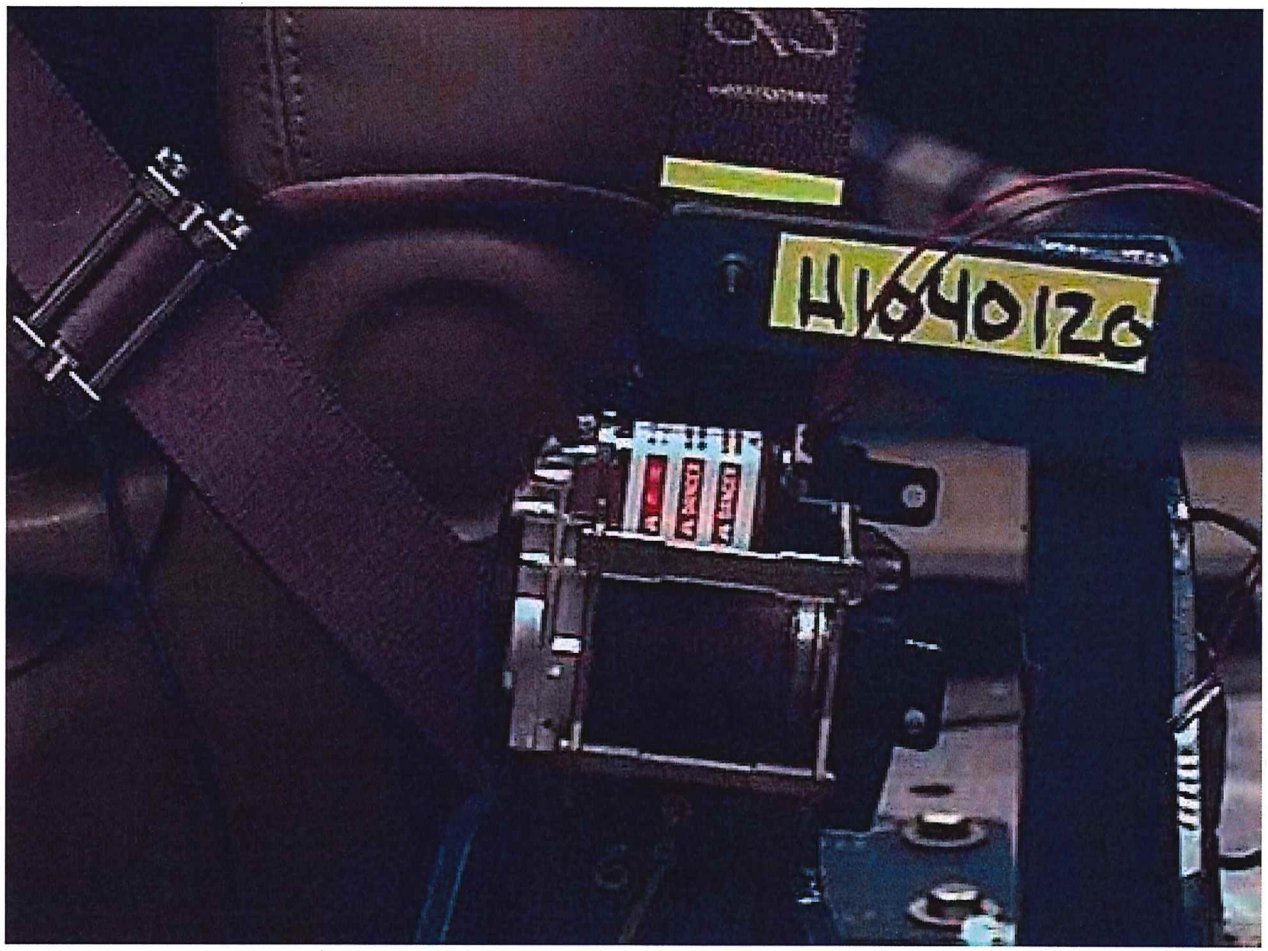


Rotopretensioner Retractor Animation

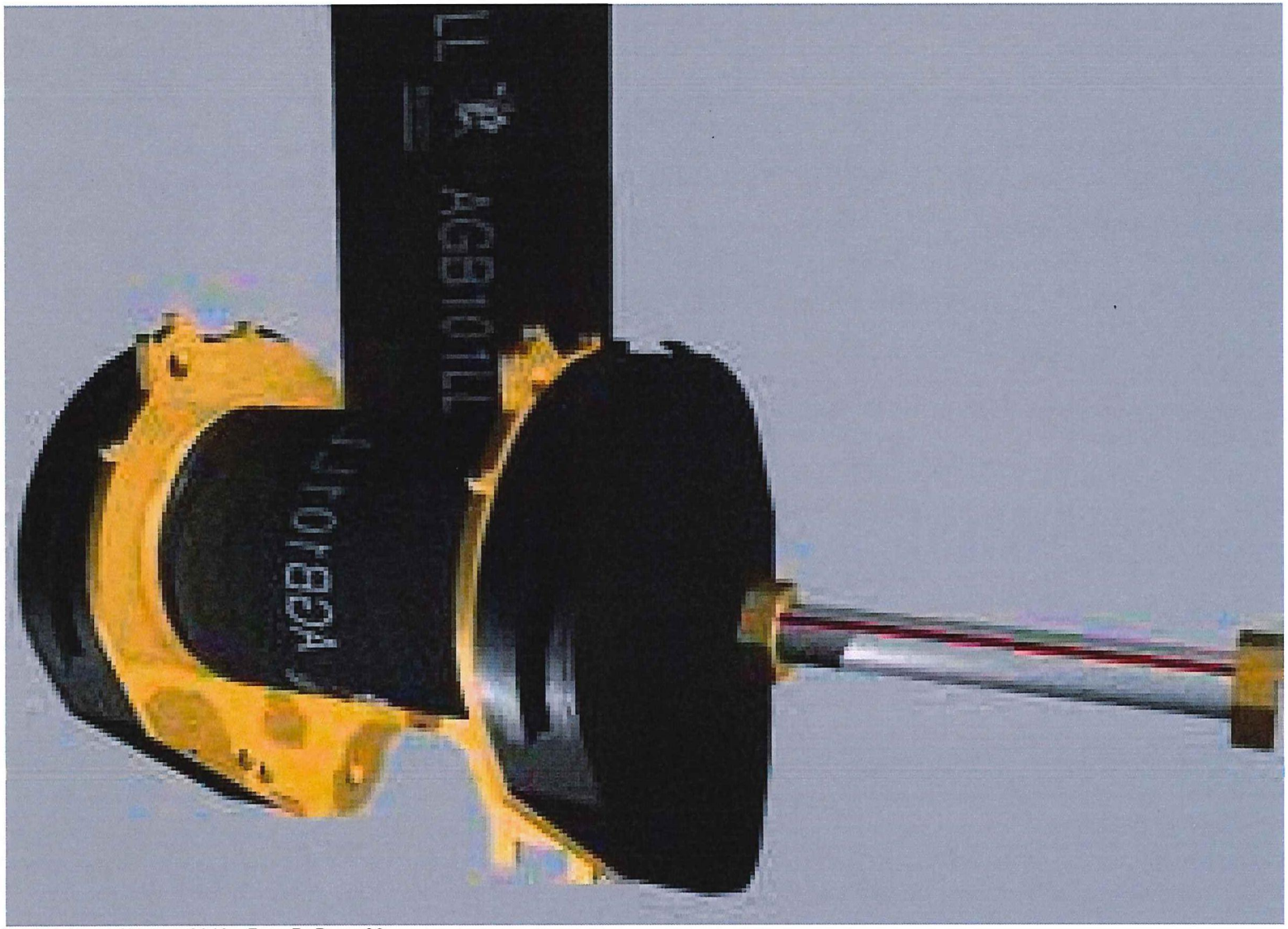


Retractor Pretensioner

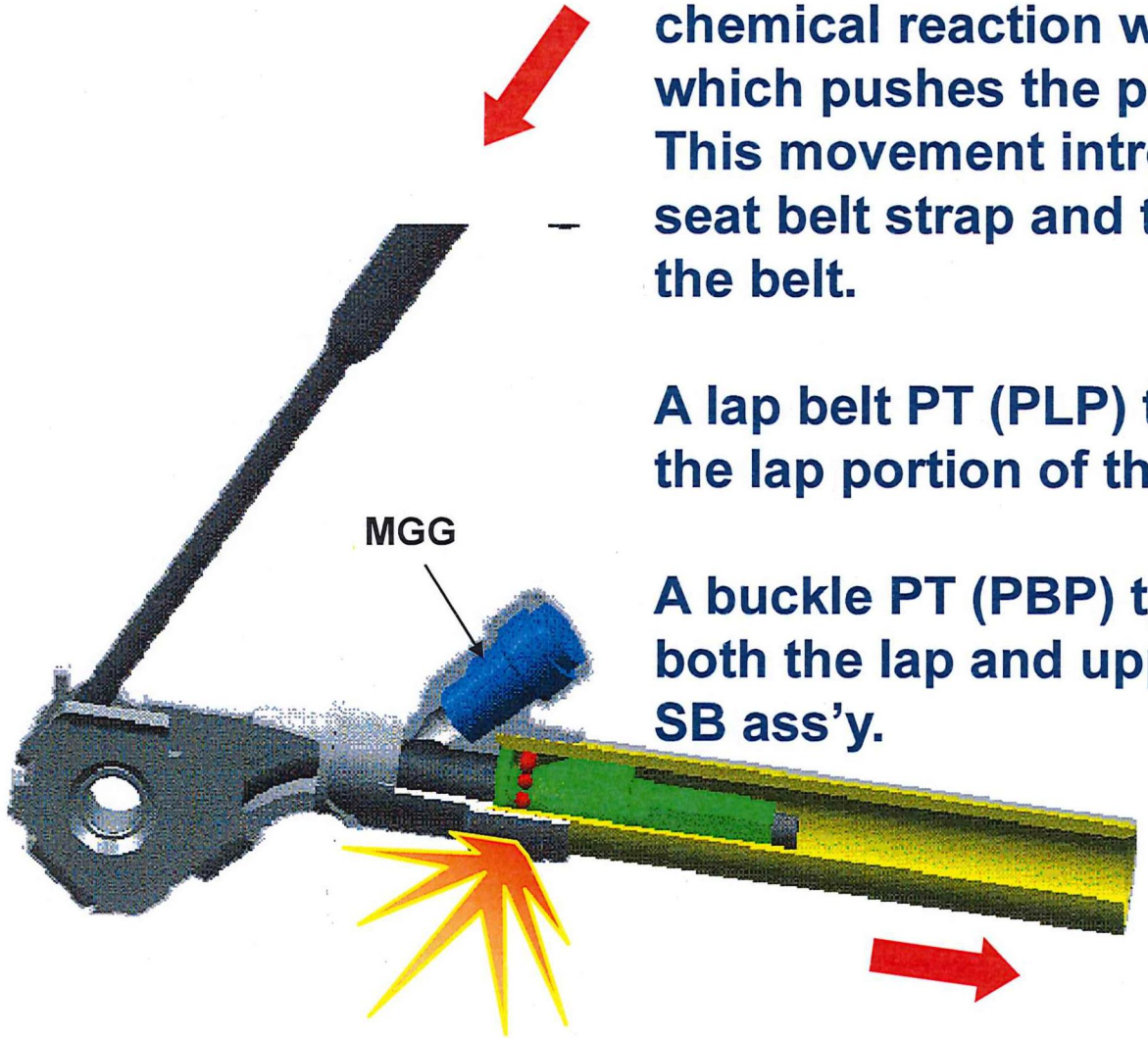
Deployment



Load Limiter Function Simulation



PLP / PBP
principle of operation



An external controller transmits an electrical signal to the initiator device of the MGG in the pretensioner. This MGG ignition starts a chemical reaction which generates a gas which pushes the piston/wire unit forwards. This movement introduces a tension on the seat belt strap and thus reduces the slack in the belt.

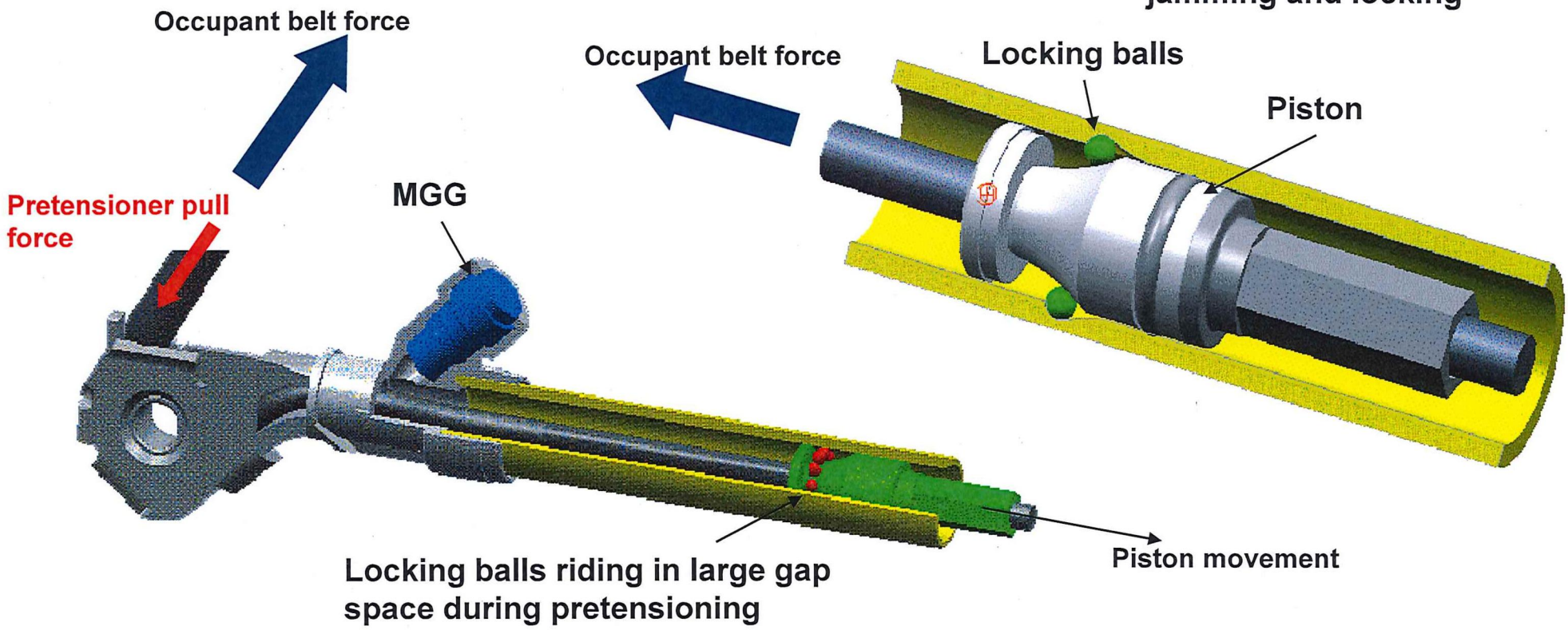
A lap belt PT (PLP) typically has more effect on the lap portion of the seat belt.

A buckle PT (PBP) typically has an effect on both the lap and upper torso segments of the SB ass'y.

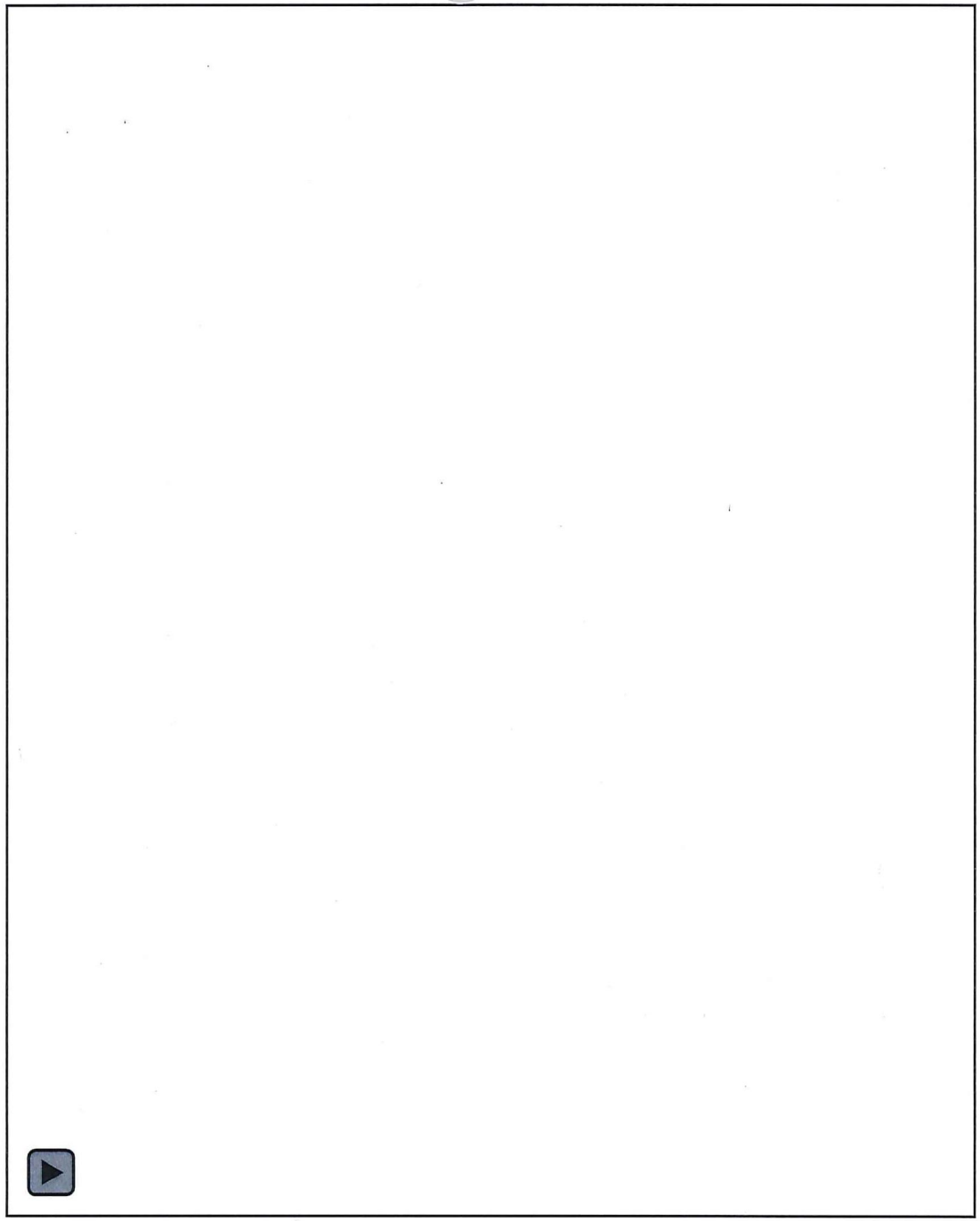
PLP / PBP

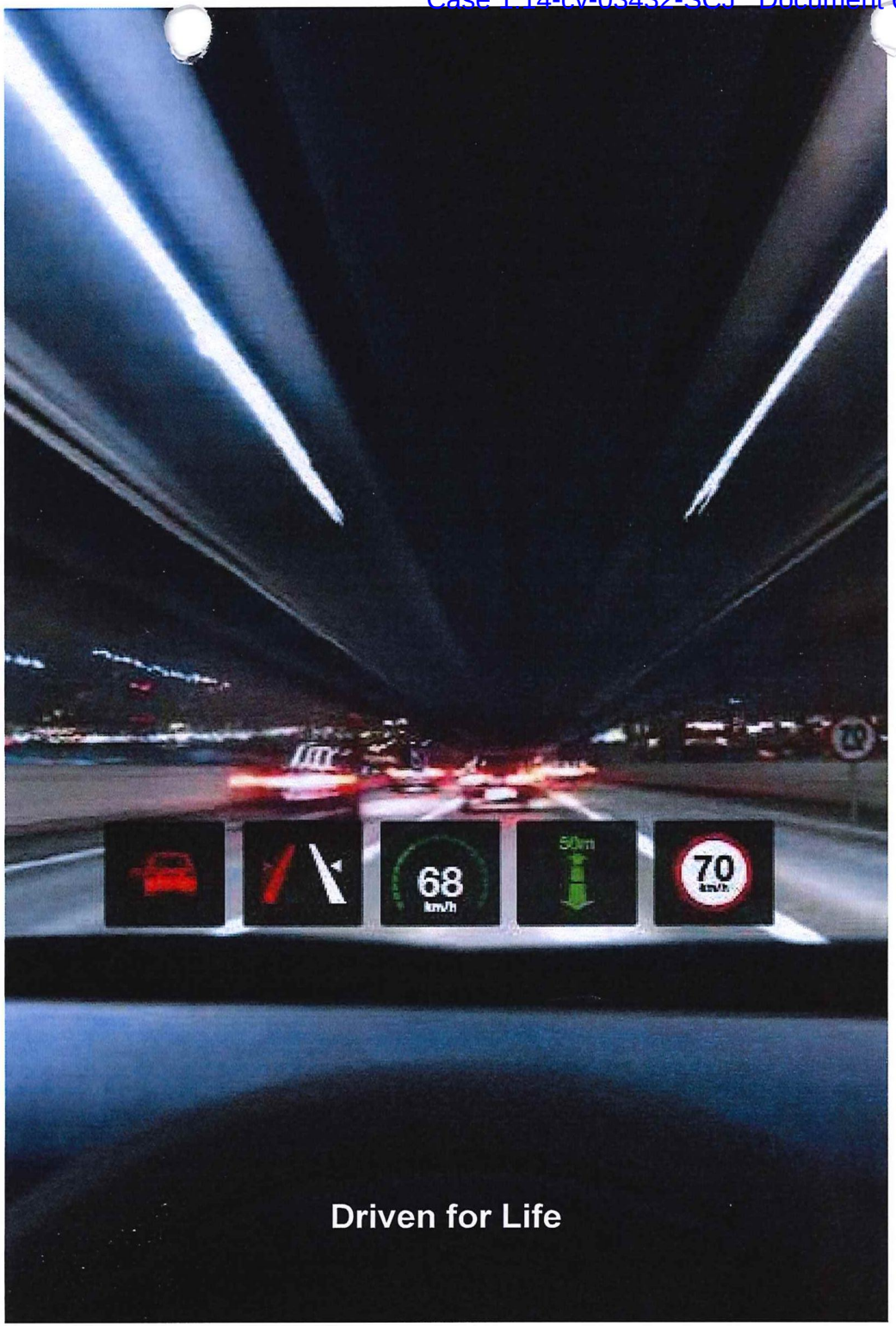
Locking principle

Locking system :
To avoid back-travel, the device is locked using a ball and conus locking clutch



PBP
Deployment





A Basic Overview and Introduction to FMVSS, ECE R16 and NCAP Requirements for Seat Belts

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Overview

Federal Motor Vehicle Safety Standards (FMVSS) are managed by the National Highway Traffic Safety Administration (NHTSA), which is a part of the Department of Transportation (DOT). They are published annually by the Government Printing Office (GPO) in the Code of Federal Regulations (CFR). Activity on all FMVSS requirements is published in the daily Federal Register (FR) when activity occurs. FMVSS requirements apply **only** to vehicles sold in the United States of America.

Canadian MVSS closely follows (and is almost identical) to US FMVSS requirements. Technical Standards Document (TSD) – 209 is basically a copy of FMVSS209.

ECE UN R16 requirements affect the Economic Commission for Europe (ECE) and is managed by the United Nations and the Inland Transport Committee. ECE UN R16 requirements apply to all vehicles to be sold in Europe.

Overview - cont'd

For Rest Of World (ROW) seat belt requirements, ECE R16 is used where no standard exists. Most countries that have specific seat belt regulations base them on ECE R16.

The New Car Assessment Program (NCAP) was initiated by the USA National Highway Traffic Safety Administration (NHTSA) in 1978 as a means for providing Consumers a simple way to compare the relative safety of vehicles in frontal crashes. Star ratings (1-5, 1 =worst, 5=best) are awarded and reported.

NCAP programs now exist in most major regions of the world. NCAP programs include USNCAP, EuroNCAP, JapanNCAP, AustraliaNCAP, KoreaNCAP, ChinaNCAP, LatinNCAP as well as others.

FMVSS 201/208/209/210/302/ NCAP and ECE UN R16 for Seat Belts

- FMVSS201 defines requirements for occupant protection in interior impact (head impact on pillars, height adjusters, D-rings, etc.) Demonstration of compliance to this requirement is the responsibility of the vehicle manufacturer, but component suppliers must work closely with vehicle manufacturers to insure compliance.
- FMVSS 208 defines occupant restraint requirements and some vehicle level requirements for seat belt systems. Demonstration of compliance is the responsibility of the vehicle manufacturer. There are some seat belt requirements in 208 so suppliers need to work closely with vehicle manufacturers.
- FMVSS 209 are the component level seat belt requirements. Demonstration of compliance is the responsibility of the seat belt supplier.
- The test procedures for FMVSS 209 are defined in TP-209.

FMVSS 201/208/209/210/302/ECE R16 and NCAP for Seat Belts

- FMVSS 210 governs where the seat belts are mounted in the vehicle and how strong the vehicle anchorages must be. Demonstration of compliance is the responsibility of the vehicle manufacturer. Pillar loop height adjusters are considered part of the anchorage so suppliers must work closely with vehicle manufacturers.
- FMVSS 302 defines the flammability requirements for materials used in vehicle interiors. Demonstration of compliance for items like webbing need to be supplied by the seat belt supplier to the vehicle manufacturer.
- **N**ew **C**ar **A**ssessment **P**rogram (NCAP) is NOT a regulatory requirement but is a Customer and Market expectation. NCAP ratings are required by law to be on new vehicle sales window stickers in the United States.

ECE UN R16 Seat Belt Requirements

ECE UN R16 is a combined seat belt system and seat belt component level requirement.

Testing includes, corrosion, dust, temperature, cycling, accelerated lock and other functional requirements for retractors, buckles, tongues, anchors, pillar loops, bolts, webbing and other seat belt components and assemblies.

ECE UN R16 includes demonstration of ongoing compliance by way of Conformity Of Production (COP) testing, which requires use of conditioned production parts in a dynamic test.

ECE UN R16 has specific labeling requirements that must be strictly adhered to.

ECE UN R16 requires a third party "type approval" and certification for new assemblies and "extensions" (test/evaluation/approval) for significant changes.

FMVSS208 vs. ECE UN R16 Seat Belt Req'ts

FMVSS 208 is a vehicle system level dynamic test for the occupant restraint system. It is an occupant injury criteria based system with measurements taken for Head Injury Criteria (HIC), Neck Injury Criteria (Nij), Femur loads, Chest deflection, etc.)

ECE UN R16 is mix of seat belt requirements and a dynamic test requirement. The dynamic test requirement is an occupant excursion based criteria system and not occupant injury numbers/calculation type system like FMVSS208. ECE UN R16 uses a dynamic test to evaluate the amount of occupant forward excursion measured at the chest (300mm max.) and at the hip point (200mm max.).

FMVSS208 (all FMVSS) are self-certified by the manufacturer.

ECE UN R16 requires a type approval process by way of a third party test house. If all parts meet requirements, then a type approval number is issued and must show up on seat belt part labels according to the regulatory requirement.

New Car Assessment Program (NCAP)

The NCAP system is a simple way to rate a vehicle's ability to protect an occupant during a crash event. This is determined through a calculation of test dummy results during an actual vehicle crash test at 35mph to a standard crash test profile/setup. (FMVSS 208 is 30mph)

The test result output is a "star" rating of 1 - 5 stars, 5 star being the best rating.

NCAP is not a regulatory requirement in any market although NCAP ratings are required to be included in new vehicle sales window stickers so the public can quickly see and determine that vehicles ability to protect an occupant during a crash.

ALL OEM Customers MUST meet FMVSS208 & ECE R16 requirements (depending on market) with a very strong focus on being able to achieve and report a 5 star NCAP rating in the vehicle sales market.

5 star NCAP rating is a significant marketing tool for the OEM.

Even though not a regulatory requirement, NCAP is managed and reported by the Governmental Regulatory Agencies (NHTSA in USA).

NCAP exists in all major regions/markets (USNCAP, EuroNCAP, JNCAP, Latin NCAP, etc.)

NCAP and Belt System Contributions to Performance

The New Car Assessment Program (NCAP) was initiated by the National Highway Traffic Safety Administration (NHTSA) in 1978 as a means for providing Consumers a simple way to compare the relative safety of vehicles in frontal crashes.

Injury Risk Curve information(star ratings) is a resultant calculation of a measure of force of impact to a test dummy.

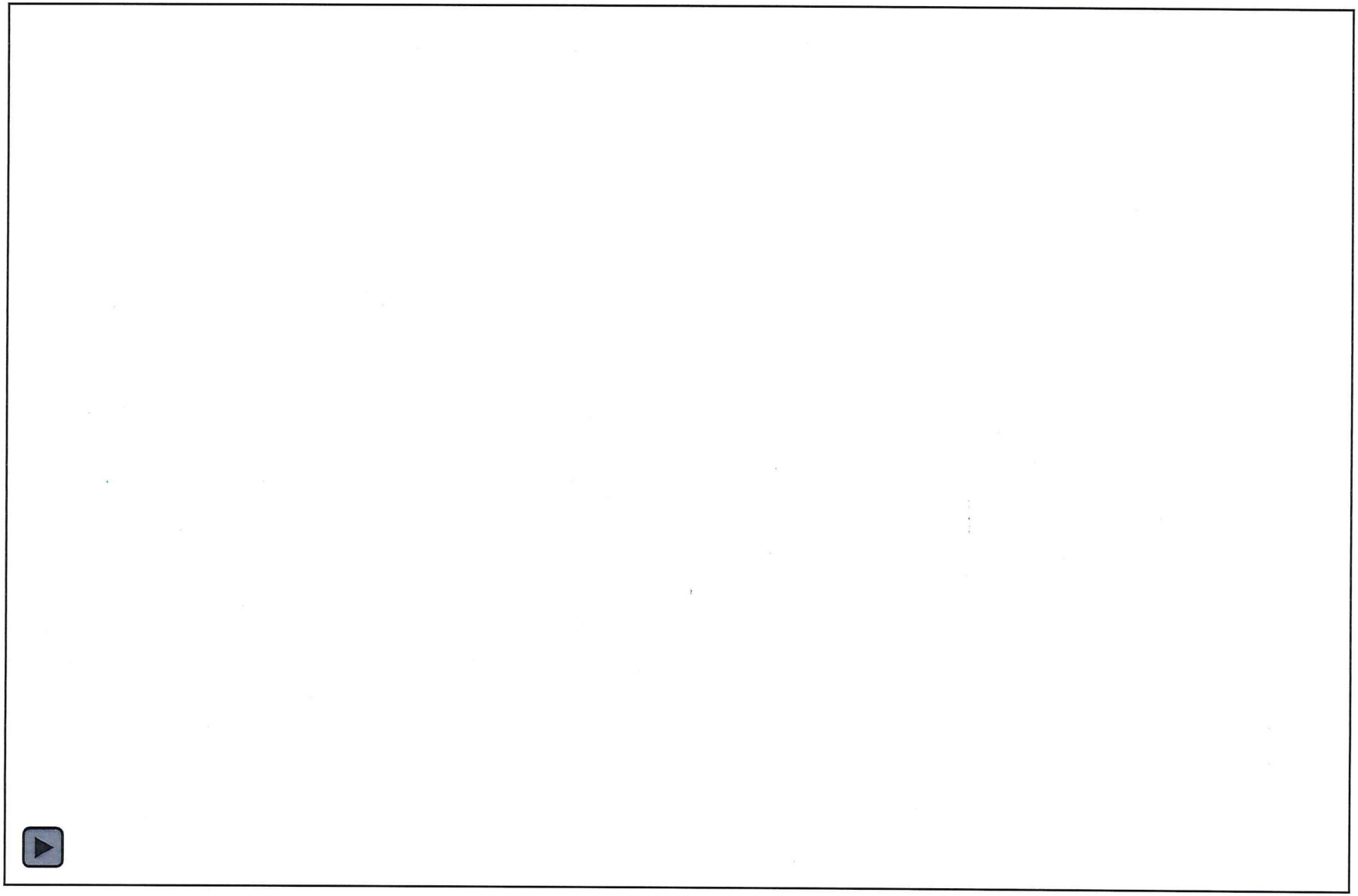
The higher the star rating, the less likelihood of serious injury.

- 5 star = 10% or less chance of serious injury
- 4 star = 11%-20% chance of serious injury
- 3 star = 21%-35% chance of serious injury
- 2 star = 36%-45% chance of serious injury
- 1 star = 46% or greater chance of serious injury

Star ratings are a result of total system performance which include vehicle performance, Seat Belts and interaction of the occupant with airbags and other devices in the vehicle.

New Car Assessment Program - NCAP

Latin NCAP Example – Baseline Testing Before Latin NCAP Existed



The End

Thank You for Your Attention!

Any Questions?

I appreciate receiving feedback and comments on this training as well as suggestions on how to improve it. Please contact me at – david.prentkowski@autoliv.com